Annals of Clinical and Analytical Medicine
Original Research

Comparison of balance and coordination abilities between asthmatic patients and healthy subjects

Ayşenur Yılmaz[1], Süleyman Gürsoy[1], Orçin T. Atalay[1], Fatma B. Evyapan[2]
[1] School of Physical Therapy and Rehabilitation
[2] Department of Chest Diseases, Faculty of Medicine, Pamukkale University, Denizli, Turkey

Abstract
Aim: Previous studies have shown that structural defects and deformities develop in the chest wall due to decreased thoracal mobility in asthmatic patients. Besides, psychological problems and emotional states play an important role in the pathophysiology of asthma. These conditions may affect balance and coordination. Therefore, the study aimed to compare the balance and coordination capabilities of asthmatic patients with healthy individuals.
Material and Methods: The study included patients diagnosed with asthma by GINA and healthy volunteer subjects. Forty-nine asthma patients aged between 18-50 years and fifty-one healthy subjects were included in the study. Balance was assessed by SportKat Kinesthetic Ability Trainer (SPORTKAT550), Five Times Sit-to-Stand Test (FTSTS), and Timed Up and Go (TUG) test. Coordination ability was assessed by the Finger-to-Nose Test (FNT) and Toe-Tap Test (TTT). In addition, Beck Anxiety Scale (BAS) was used to assess anxiety, and Beck Depression Scale (BDS) was used to assess depression.
Results: The mean age of the asthmatic group was 35,3±10,3 years, and the mean age of the healthy group was 36,17±8,47 years ($p>0,05$). When the group results were compared, there was a significant difference in SportKAT550 scores, FTSTS, TUG, FNT, TTT, BAS, and BDS ($p<0,05$).
Discussion: A decrease in the balance and coordination capabilities was found in asthmatic patients. It was observed that asthma patients had high levels of anxiety and depression. Balance and coordination, which are important neuromotor components of most activities of daily living, should be evaluated in asthmatic patients.

Keywords
Asthma, Balance, Postural, Coordination

DOI: 10.4328/ACAM.20741 Received: 2021-06-09 Accepted: 2021-08-19 Published Online: 2021-09-07 Printed: 2021-12-01 Ann Clin Anal Med 2021;12(12):1337-1342
Corresponding Author: Ayşenur Yılmaz, School of Physical Therapy and Rehabilitation, Pamukkale University, Denizli, Turkey.
E-mail: fzt.aysenurgungor@gmail.com / aysenury@pau.edu.tr P: +90 258 296 42 46 / +90 543 283 38 19 F: +90 258 296 44 94
Corresponding Author ORCID ID: https://orcid.org/0000-0002-2357-0351

Introduction

Asthma is one of the most common chronic diseases in the world (Available at: www.ginasthma.org). Studies have shown that posture and balance changes occur in individuals with asthma [1,2], as well as respiratory symptoms (Available at: www.ginasthma.org). Balance problems in individuals with lung disease may be due to many physiopathological reasons. It has been reported that causes such as hip weakness, poor nutrition or malnutrition, anxiety, depression, cognitive problems, and medicines may increase the risk of falls in patients with lung disease [1,3]. Balance and coordination, which are the basic components of daily activity, are intertwined [4]. Coordinated movements require good balance and posture, as well as correct sequence and timing of synergistic and reciprocal muscle activities [5]. Therefore, impairment in balance can affect coordination.

Accessory inspiratory and expiratory muscles work excessively due to airway obstruction in asthma patients, causing hypertrophy [1,3]. Because of this pressure causing a decrease in muscle length and strength, muscles become shorter and lose their elasticity [6]. As a result, changes occur in the chest biomechanics. These changes are not limited to this region but are reflected on the whole body. Therefore, any changes that occur in the chest will affect whole-body biomechanics [7]. In the study on asthma patients, protrusion of head and shoulders occurred in patients with mild, moderate, and severe persistent asthma and patients with decreased mobility of shoulder internal rotation, chest wall, and thoracic spine. This was found to be related to the onset time of the symptoms [1].

In addition, a close relationship between anxiety and asthma is frequently described in the literature [8,9]. Anxiety is associated with clinical conditions such as dizziness and balance problems [10]. Dizziness and vestibular dysfunction occur in 90% of patients with anxiety [11]. However, depression and cognitive problems are related to problems such as immobility and balance disorder [12].

Studies have shown that high anxiety levels [13], depression [14], and hypoxia [5] affect postural control and motor coordination. Therefore, we think coordination may be impaired with anxiety, depression, and hypoxia due to asthma attacks. Unfortunately, there are not many previously published studies that analyzed on coordination of asthma patients.

This study was planned to compare the balance and coordination capabilities of asthmatic patients with healthy individuals.

Material and Methods

Participants

This study was carried out with the participation of 49 asthma patients and 51 healthy individuals. Our study was carried out between February 2016 - January 2018. Patients meeting the inclusion criteria were included.

The inclusion criteria for asthma patients: between the ages of 18-50, no heart or other lung disease, no neurological or orthopedic problems, no operations on the upper extremity, lower extremity and/or waist, no ongoing painful musculoskeletal problems, stable symptoms, and medications.

The inclusion criteria for the healthy group: between the ages of 18-50, no heart or lung disease, no smoking, no psychological problems, no drugs or alcohol consumption that may affect balance, no neurological or orthopedic problems, cases who have not undergone an operation in the upper extremity, lower extremity and/or lumbar region, who do not have ongoing painful musculoskeletal problems, who have not had respiratory tract infection in the last three months.

The exclusion criteria for both the groups were as follows: who were treated with psychiatric treatment, were smokers or ex-smokers; had a respiratory infection in the past three months; limited joint movement, chronic musculoskeletal pain, vestibular disorders, or other balance disorders.

Data Collection Tools

1. Respiratory Function Test

Pulmonary function tests were evaluated with the COSMED Pony Fx portable mouth pressure measuring device. Forced expiratory volume in one second (FEV1), forced vital capacity (FVC), Tiffeneau index (FEV1 / FVC), Peak expiratory flow (PEF), and Maximal Mid-Expiratory Flow Rate (FEF25-75) values were measured [15].

2. Beck Anxiety Scale

It is one of several scales aimed at evaluating the anxiety state of the individual. The highest score is 63. The high score obtained from the scale indicates the severity of anxiety experienced by the individual [16].

3. Beck Depression Scale

It is a self-assessment scale that can be applied to both psychiatric patient groups and healthy people. The higher the total score, the higher the severity of depression [17].

4. The Evaluation of Balance:

4.1. Kinesthetic ability trainer (SPORTKAT 550): The patients were asked to follow the moving target point circling clockwise for 30 seconds on the monitor (Figure 1). During the test, the subjects received feedback from the monitor, continuously following the position of the sign indicating the displacement of the center of gravity on the platform area with respect to the target point. Low scores in tests indicate that balance performance is good [18].

4.2. Timed Up and Go (TUG) test: The TUG test was used to measure balance and functional mobility. Scoring is calculated by measuring how many seconds the test took to finish [4].

4.3.Five Times Sit-to-Stand Test (FTSTS): FTSTS test begins with the participant seated in the middle of the chair (45cm), back straight. The participant is raised to a complete stand and returns to the initial position. The duration was recorded [19].

5. The evaluation of coordination

5.1.Finger-to-Nose Test: The finger-to-nose test (FNT) was modified from a basic physical therapy neurologic assessment to ensure standardization of the test procedures [20]. The subject was asked to sit on a chair and feet flat on the floor. A target is a black circle that can be moved on a vertical axis according to the subject's height. The task required the subject to contact both the target and the nose as many times as possible in 20 seconds. The test was performed three times. The best value was noted [4].

5.2.Toe-Tap Test: The toe-tap test (TTT) was used for the coordination of foot movement. Each subject was asked to move forward in a chair, so the lower legs were not in contact with the chair and the knees and ankles were both at a 90°

angle. A circular target (diameter, 5.75 cm) was placed under the subject's heel, and the second target of equal diameter was placed under the subject's toes. The task required the subject to contact each of the heel and toe targets as many times as possible in 20 seconds. The test was performed three times. Again, the best value was noted [4].

Statistical analysis

As a result of the power analysis, it was calculated that at least 94 people (47 people per group) could get 80% power with 95% confidence [2]. The SPSS package program was analyzing the data. Continuous variables were presented as mean ± standard deviation and categorical variables as number and percentage. The Significance Test of the Difference Between the Two Average in comparing the independent group differences when the parametric test assumptions were provided; If the parametric test assumptions were not provided, the Mann-Whitney U test was be used to compare the independent group differences. Since all data did not show normal distribution, the relationship between the two variables was analyzed by Spearman correlation analysis. A correlation coefficient between 0 and 0.3 was considered a weak relationship, between 0.3 and 0.6 as a moderate relationship, and between 0.7 and 1.00 as a strong relationship. Statistical significance level was accepted as $p < 0.05$.

Ethical considerations: The study was approved by the Ethics Board Committee of Pamukkale University Medical Faculty (Ref No:60116787-020/71601 Date:17/11/2016)), and ethical principles laid down in the Declaration of Helsinki have been followed.

Results

Subjects

When the groups were compared, there was no significant difference between the two groups regarding the mean age and weight ($p > 0.05$). A statistical difference was found between the two groups in terms of the mean height and BMI ($p<0.05$). When the groups were compared in terms of FEV1, FVC, FEV1 / FVC, and PEF were significantly different ($p<0.05$). A statistical difference was found when the anxiety and depression results of the groups were compared. ($p<0.05$) (Table 1). The mean duration of disease in asthma patients was determined as 17,59 ± 9,16 years.

Comparison of balance and coordination tests

When the groups were compared in terms of SportKAT dynamic balance total score and subcategories (Front, Back, Right, Left), TUG, FTSTS, FNT, and Toe-tap test were found a significant difference in favor of Healthy Group ($p<0.05$) (Table 2).

The relationship emotional state, age, duration of disease, respiratory parameters balance and coordination tests in the asthmatic group

A moderate correlation was found between Dynamic balance total score, Beck anxiety and Beck depression scores ($r = 0.621$, $p = 0.000$, $r = 0.618$, $p = 0.000$ respectively). A moderate correlation was found between TUG, FTST, Beck anxiety ($r = 0,496$, $p = 0.000$, $r = 0.478$, $p = 0.001$ respectively). A moderate correlation was found between TUG, FTST, Beck depression scores ($r = 0.557$, $p = 0.000$, $r = 0.483$, $p = 0.000$, respectively) A moderate negative correlation was found between FNT, Toe-tap test, Beck anxiety ($r = -0.465$, $p = 0.001$, $r = -0.391$, $p = 0.005$, respectively). A moderate negative correlation was found between FNT, Toe-tap test, Beck depression scores ($r = -0.354$, $p = 0.013$, $r = -0.378$, $p = 0.007$) (Table 3).

A moderate correlation was found between age, dynamic balance test, TUG, ($r = 0.601$, $p = 0.000$, $r = 0.441$ $p = 0.002$, respectively). A moderate negative correlation was found between age, FTST, FNT and TTT ($r = -0.392$, $p = 0.005$, $r = -0.495$, $p = 0.000$, $r = -0.491$, $p = 0.000$, respectively). A moderate negative correlation was found between duration of disease, FNT and FTST ($r = -0.312$, $p = 0.029$, $r = -0.311$, $p = 0.029$, respectively). A moderate correlation was found between

Table 1. Comparison of demographic and clinical characteristics between two groups

Variables	Asthmatic Group (n=49)		Healthy Group (n=51)		P
	X±SD	Median (Min-Max)	X±SD	Median (Min-Max)	
Age(Year)	35,3 ±10,3	37(18-50)	36,18±8,48	37(21-49)	0,717*
Height(Cm)	161,77±9,34	160 (145-188)	165,31±8,34	165 (150-180)	0,048**
Weight(kg)	70,6±14,3	70(43-114)	66,47±10,4	64 (43-92)	0,158*
BMI (kg/m²)	26,88±4,29	26,18 (18,13-36,89)	24,33±3,39	24,91 (15,92-31,83)	0,001**
FEV1(lt)	2,83±0,63	2,61 (1,69-4,77)	2.16±0,51	2,03 (1,41-3,49)	0.000*
FVC(lt)	3,44±0.77	3,2 (2,12-5,58)	2,77±0,64	2,68 (1,90-4,87)	0,000*
FEV1/FVC	82,43±4,78	82 (72-97)	78,28±9,83	77 (55-98)	0,008**
PEF(lt)	5,75±1,45	5,25 (3,52-9,30)	4,49±1,21	4,3 (2,75-7,47)	0,000*
BAS (point)	21,65±13,53	16 (0-55)	4.07±4.82	3 (0-22)	0.000*
BDS (point)	15,32±11,28	16 (0-55)	4.17±5.75	1 (0-19)	0.000*
Sex	N	%	N	%	
Female	39	79,6	36	70,6	
Male	10	20,4	15	29,4	

*Mann-Whitney U test, ** Independent T-Test; $p < 0.05$; BAS: Beck Anxiety Scale, BDS: Beck Depression Scale, FEV1: Forced expiratory volume, FVC: Forced vital capacity, PEF: Peak expiratory flow, FEF25-75: Forced expiratory flow rate, lt=liter, %=percent min: minimum, max: maximum, X: mean, SD: standard deviation

Table 2. Comparison of balance and coordination tests between two groups

Variables	Asthmatic Group (n=49))		Healthy Group (n=51)		p
	X±SD	Median (Min-Max)	X±SD	Median (Min-Max)	
Dynamic Balance Score (Bl)	3069,04±1257,5	2630 (1106-6260)	2263,33±618,35	2261 (1175-3664)	0,001*
Front	1429,95±712.77	1348 (349-3665)	1060.56±352.67	1078 (381-1932)	0.014*
Back	1632.77±1043.62	1403 (11-5084)	1199.25±470.32	1144 (581-2955)	0.030*
Right	1705.24±989.02	1618 (17-4644)	1201.94±434	1091 (585-2670)	0.004*
Left	1351.44±602.84	1232 (29-3020)	1119.56±406.45	1031 (489-2630)	0,041*
TUG (sn)	7,31±1,72	7,04 (4.07-13.05)	6,03±1,09	5,94 (4,06-8,76)	0,000*
FTSTS (sn)	9,38±1,97	9,34 (5,28-14,35)	7,28±1,13	7,28 (4,41-9,63)	0,000*
Finger Nose Test	51,24±8,65	49 (35-73)	55,94±7,99	55 (43-79)	0,007*
Toe Tap Test	47,16±8,19	47(35-69)	53,58±10,90	53(39-79)	0,003*

*Mann-Whitney U test $p < 0.05$; TUG: Timed up and go, FTSTS: Five times sit-to-stand test

Table 3. The relationship emotional state, age, duration of disease, respiratory parameters balance and coordination tests in the asthmatic group

Variables			Dynamic Balance Score (BI)	Front	Back	Right	Left	FTSTS (sn)	TUG (sn)	FNT (circle)	TTT (circle)
Asthmatic Group	BAS	r	0,621	0.035	0.077	0.033	0.049	0,478	0,496	-0,465	-0,391
		p	0,000*	0.824	0.628	0.836	0.758	0,001*	0,000*	0,001*	0,005*
	BDS	r	0,618	0.036	0.113	0.117	0.099	0,483	0.557	-0,354	-0,378
		p	0,000*	0.822	0.474	0.460	0.533	0,000*	0,000*	0,013*	0,007*
	Duration of diseas	r	0.389	0.047	0.023	0.142	0.109	-0.312	0.335	-0.311	-0.218
		p	0.006	0.767	0.883	0.371	0.490	0.029	0.018	0.029	0.132
	Age	r	0.601	0.161	0.072	0.099	0.057	-0.392	0.441	-0.495	-0.491
		p	0.000	0.309	0.649	0.535	0.719	0.005	0.002	0.000	0.000
	Fev1 (lt)	r	-0.502	0.021	-0.111	-0.038	-0.278	0.236	-0.256	0.310	0.244
		p	0.000	0.895	0.484	0.810	0.074	0.103	0.076	0.030	0.091
	FVC(lt)	r	-0.528	0.130	-0.073	-0.020	0.045	0.215	-0.292	0.318	0.285
		p	0.000	0.413	0.642	0.900	0.775	0.138	0.042	0.026	0.047
	Fev1/FVC	r	-0.006	-0.128	-0.286	-0.192	0.025	0.108	0.061	0.052	0.058
		p	0.965	0.420	0.066	0.233	0.873	0.459	0.677	0.724	0.692
	PEF(lt)	r	-0.365	0.042	-0.018	-0.61	-0.271	0.078	-0.219	0.319	0.295
		p	0.010	0.790	0.908	0.702	0.086	0.595	0.042	0.026	0.040

*Spearman Correlation Analysis, p<0.05, p= Significance level, r= Correlation coefficient, BAS: Beck Anxiety Scale, BDS: Beck Depression Scale, TUG: Timed up and go FTSTS: Five times sit-to-stand test, Finger- nose-test: FNT, Toe-tap test: TTT, FEV1: Forced expiratory volume, FVC: Forced vital capacity, PEF: Peak expiratory flow FEF25 -75: Forced expiratory flow rate, lt=liter, %=percent min: minimum, max: maximum, X: mean, SD: Standard Deviation

Figure 1. Balance assessment with SportKAT

duration of disease, dynamic balance total score, TUG (r = 0.389, p = 0.006, r = 0.335, p = 0.018, respectively). A moderate negative correlation was found between dynamic balance total score, FEV1, FVC and PEF (r = -0.502, p = 0.000, r = -0.528, p = 0.000, r = -0.365, p = 0.010, respectively). A weak correlation was found between TUG, FVC and PEF (r = -0.292, p = 0.042, r = -0.219, p = 0.042, respectively). A moderate correlation was found between FNT, FEV1, FVC and PEF (r = 0.310, p = 0.030, r = 0.318, p = 0.026; r = 0.319, p=0.026, respectively). A weak correlation was found between TTT, FVC and PEF (r = 0.285, p = 0.047, r = 0.295, p = 0.040, respectively) (Table 3).

Discussion

In this study, which was conducted to investigate balance and coordination disorders in asthmatic patients and to compare them with healthy individuals, it was found that asthma patients have worse balance and coordination.

Balance

Our results obtained from this study indicate that asthmatic patients demonstrated poorer balance and coordination compared with healthy subjects. Balance and coordination problems in lung problems may occur due to several reasons. They stated that a significant difference in dynamic balance with open eyes might be associated with postural disorders [2]. Asthmatic patients had biomechanical changes. This condition may also cause postural control alterations. In asthmatic patients, heads and shoulders are further forward with an increased internal rotation of the shoulder, lowered chest wall expansion, reduced flexibility of the thoracic spine are seen [1]. Posturography results were affected due to these alterations because the body's center of gravity displaces. Asthmatic patients may not have been able to achieve the appropriate integration of vision and vestibular information. Therefore, asthmatic patients have larger and faster CoP displacement in conditions with the mobile platform. In addition, asthmatic patients may not be able to accomplish a better motor response to the challenge of balancing on a mobile platform because asthmatic patients have postural alterations of the chest, shoulder, and spine [1,2].

Cunha et al. (2013) stated that balance disorders are anxiety and vestibular problem origin [2], Almeida et al. (2013) stated that the mediolateral balance disorders are postural disorder origin [1]. We found that asthma patients were worse than healthy people in balance in the antero-posterior and medio-lateral. They are worse in antero-posterior dynamic balance tests because of fear of falling. We think that the difference in the medio-lateral balance in dynamic balance tests will be related to the presence of postural alterations.

In this study, It was observed that our asthma patients had high levels of anxiety and depression. Psychological problems and emotional states play an important role in the pathophysiology of asthma. Studies have shown a strong relationship between anxiety and asthma [8,9]. It is reported that the balance will

be disturbed by anxiety [2,10,11]. In addition, in depressive patients, deceleration in movements is common. In the study, a relationship was found between depression, immobility, and balance disorders [12]. In our study, similar to the literature, we found a moderate relationship between balance and emotional states.

Coordination

FNT and TTT results were worse in asthma patients. Kertzman et. (2010) performed FNT and cognitive control tests on the subjects with depression. They found significant differences in these tests. It is reported that there is a slower reaction time in the elongation movements in the presence of depression [14]. Butcher et al. (2004) reported that the coordination of patients with COPD is impaired in their study. Similarly, asthma is also an obstructive disease; therefore, the coordination capabilities of asthma patients may be impaired [4]. In addition, various pathophysiological and environmental conditions, such as sleep apnea and chronic obstructive pulmonary disease temporarily high altitude, are among the conditions that cause intermittent hypoxia. It has been shown that intermittent hypoxia affects balance and coordination in studies performed at high altitudes. Intermittent hypoxia is an effective stimulus in the human body that elicits compliance responses at various levels in the circulatory, respiratory, sleep systems, and other organ systems. Studies have shown that this stimulus causes neurocognitive disorders as well as myocardial ischemia, cerebral ischemia, hypertension, balance disorder, coordination, and oxidative damage [21,22]. Hypoxia during acute attacks is observed in asthma (Available at: www.ginasthma.org).

There are studies showing that there was a decrease in motor performance and coordination capabilities in children with high anxiety levels. Anxiety and depression have been shown to be associated with prolongation of reaction times and deceleration in movements [13,14]. In our study, the movements of asthma patients were slower.

Patients with COPD using oxygen were found that the finger-nose test, TTT, and the TUG test had a moderate relationship with FEV1, FVC, and PEF [4]. In our study, we found a moderate relationship between respiratory parameters, balance, and coordination. However, balance and coordination disorders may be due to different reasons, such as drug use. Therefore, other reasons should be investigated.

The limitation of our study is that our patients do not have homogeneous distribution in terms of sex. Also, the effect of drugs has not been examined. On the other hand, the strengths of our study are having a control group, a large sample size, and evaluate anxiety, depression and coordination.

Conclusion

Asthmatic patients demonstrated poorer balance and coordination performances as compared to healthy subjects. Therefore, we suggest that the balance and coordination of the asthmatic patients should be evaluated. It would be useful to identify these neuromotor components and add them to rehabilitation programs. So that balance and coordination abilities can be improved.

Acknowledgment

The authors would like to thank people for participating in this study.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

Funding: *None*

Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

References

1. Lunardi AC, Marques da Silva CCB, Rodrigues Mendes FA, Marques AP, Stelmach R, Fernandes Carvalho CR. Musculoskeletal dysfunction and pain in adults with asthma. Journal of Asthma 2011; 48 (1): 105-110. Doi:10.3109/02770903.2010.520229

2. Cunha AG, Nunes MP, Ramos RT, Carvalo-Pinto RM, Boffino CC, Martins, FC, et al. Balance disturbances in asthmatic patients. Journal of Asthma 2013; 50 (3): 282-286. https://doi.org/10.3109/02770903.2012.750668

3. Roig M, Eng JJ, Road JD, Reid WD. Falls in patients with chronic obstructive pulmonary disease: a call for further research. Respiratory Medicine 2009; 103 (9): 1257-1269. Doi: 10.1016/j.rmed.2009.03.022.

4. Butcher SJ, Meshke JM, Sheppard MS. Reductions in functional balance, coordination, and mobility measures among patients with stable chronic obstructive pulmonary disease. Journal of Cardiopulmonary Rehabilitation and Prevention 2004; 24 (4):274-280. Doi:10.1097/00008483-200407000-00013

5. Laurent G, Gordon P, Evan B, Shimon E, Sten G, Uri G, et al. Dynamic Coordination in the Brain; 2010 p.59-82.

6. Stewart A. More muscle in asthma, but where did it come from. Am J Respir Crit Care Med 2012;185 (10):1035–7. Doi: 10.1164/rccm.201203-0457ED.

7. Dalleau G, Leroyer P, Beaulieu M, Verkindt C, Rivard CH, Allard P. Pelvis morphology, trunk posture and standing imbalance and their relations to the Cobb angle in moderate and severe untreated AIS. PloS One 2012; 7 (7): e36755. Doi:https://doi.org/10.1371/journal.pone.0036755

8. Di Marco F, Verga M, Santus P, Giovannelli F, Busatto P, Neri, et al. Close correlation between anxiety, depression, and asthma control. Respiratory Medicine 2010; 104(1): 22-28. Doi: 10.1016/j.rmed.2009.08.005

9. Rosenkranz MA, Davidson RJ. Affective neural circuitry and mind–body influences in asthma. Neuroimage 2009; 47 (3): 972-980. Doi:10.1016/j.rmed.2009.08.005.

10. Gurgel JDC, Costa KVT, Cutini FN, Sarmento Júnior KMDAS, Mezzasalma MA, Cavalcanti HVR. Dizziness associated with panic disorder and agoraphobia: case report and literature review. Revista Brasileira de Otorrinolaringologia 2007; 73(4): 569-572. Doi:10.1016/s1808-8694(15)30111-7

11. Asmundson GJ, Larsen DK, Stein MB. Panic disorder and vestibular disturbance: an overview of empirical findings and clinical implications. Journal of Psychosomatic Research 1998; 44 (1): 107-120. https://doi.org/10.1016/S0022-3999(97)00132-3

12. Kamińska MS, Brodowski J, Karakiewicz B. Fall risk factors in community-dwelling elderly depending on their physical function, cognitive status and symptoms of depression. International Journal of Environmental Research and Public Health 2015; 12(4): 3406-3416. Doi: 10.3390/ijerph120403406.

13. Skirbekk B, Hansen BH, Oerbeck B, Wentzel-Larsen T, Kristensen H. Motor impairment in children with anxiety disorders. Psychiatry Research 2012; 198 (1): 135-139. Doi: 10.1016/j.psychres.2011.12.008.

14. Kertzman S, Reznik I, Hornik-Lurie T, Weizman A, Kotler M, Amital D. Stroop performance in major depression: Selective attention impairment or psychomotor slowness?. Journal of Affective Disorders 2010; 122 (1): 167-173. doi: 10.1016/j.jad.2009.08.009.

15. Ruppel GL, Enright PL. Pulmonary function testing. Respiratory care 2012; 57(1), 165-175.

16. Beck AT, Ward CH, Mendelson M, Mock J & ERBAUGH J. An inventory for measuring depression. Archives of General Psychiatry 1961; 4(6), 561- 571.

17.Beck AT, Steer RA, Carbin MG. Psychometric properties of the Beck Depression Inventory:Twenty-five years of evaluation. Clinical Psychology Review 1998; 8(1), 77-100

18. Kilavuz G, Cavlak U. Analysıng the relatıonshıp between physıcal parameters and balance abılıty ın healthy young males: an experience with sportkat 550. Edıtorıal Staff, 37.

19. Whitney SL, Wrisley D, Marchetti GF, Gee MA, Redfern MS, Furman JM. Clinical measurement of sit-to-stand performance in people with balance disorders: validity of data for the Five-Times-Sit-to-Stand Test. Physical Therapy 2005; 85 (10): 1034-1045. https://doi.org/10.1093/ptj/85.10.1034

20. Gelb DJ. Introduction to Clinical Neurology: The Neurologic Examination. 2nd ed. Woburn, MA: Butterworth-Heinemann; 59 (2000).

21. Baumgartner RW, Bartsch P. Ataxia in acute mountain sickness does not improve with short-term oxygen inhalation. High Alt Medicine & Biology 2002; 3: 283-287. DOI:10.1089/152702902320604269.
22. Soguel-Schenkel N, Burdet L, de Muralt B, Fitting JW. Oxygen saturation during daily activities in chronic obstructive pulmonary disease. Eur Respir J 1996; 9: 2584-2589. DOI:10.1183/09031936.96.09122584

How to cite this article:
Ayşenur Yılmaz, Süleyman Gürsoy, Orçin T. Atalay, Fatma B. Evyapan. Comparison of balance and coordination abilities between asthmatic patients and healthy subjects. Ann Clin Anal Med 2021;12(12):1337-1342